Studies on Mollusk Populations

VI. -- *Tegula funebralis* (A. Adams, 1855)

(Mollusca : Gastropoda)

BY

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(5 Text figures)

On pages 316 and 317 of the Proceedings of the Zoological Society of London for the year 1854 (published on May 8, 1855) A. Adams described our common intertidal black turban as follows:

> 25. Chlorostoma funebrale, A. Adams. *C. testa turbinata, imperforata, nigra, glabra, longitudinaliter oblique striata, ad suturas crenulata, anfractibus convexiusculis, ultimo rotundato, basi planiusculo, regione umbilicali valde impressa, callo albo obtecta; columella superne sinuata, antice bituberculata, tuberculo supremo prominente; labro nigro marginato. Hab.* California. (Mus. Cuming.)
> This species is somewhat like *C. moestum,* Jonas, but the spiral callus surrounding the umbilicus is not prominent as in that species.

It is to be stressed that he clearly stated it to be imperforate. Carpenter (1864) distinguished a variety which he named *subapertum* (pp. 627 and 652):

> 21. *Chlorostoma funebrale* (et var. *subapertum.* One sp.).
>
> 277 b. *Chlorostoma funebrale,* var. *subapertum,* with umbilical pit.

This variety, apparently based on a single shell, may be assumed to be from the "Vancouver district," specifically from "Neeah Bay, W. T." (Carpenter, *l. c.,* pp. 626, 627). What was then the Washington Territory is now the State of Washington. From Carpenter's account, however, it is not entirely clear where exactly the variant shell came from since it was contained in one of many boxes of shells received from the ardent collector, Swan, who, moreover, "trained the native children to pick up shore-shells in large quantities."

No illustrations were available for the typical species or for the variant until Dall in Williamson (1892) gave the first figure of a specimen which is presumed to be the type of Carpenter's variety (see Figure 1). As the description by Carpenter (*l. c.,* p. 652) is inadequate for a decision as to what constituted a pit in his view, we must rely on Dall's figure to be indeed the type figure; if we assume this to be correct, then an umbilical pit may be stated to be a shallow but distinct depression in the umbilical area.

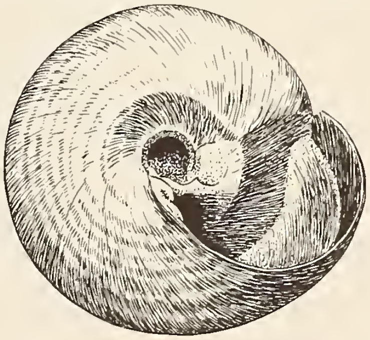

Figure 1: Copy of figure 6, plate 21, Proceedings United States National Museum, volume 15: "6. *Chlorostoma funebrale* A. Adams, variety *subapertum* Cpr., basal view of type specimen showing umbilical pit; 30 millimeters, 123496"

As indicated previously (Stohler, 1950), the presence or absence of an umbilical opening, pit or depression may vary greatly in any given population of certain species of *Tegula.* Similar results were obtained in a study of populations of *Tegula rugosa* (A. Adams, 1853) (Stohler, 1963).

Table 1

Relative Frequency of Deep Umbilical Pits in Populations of *Tegula funebralis* from the Eastern Pacific

	flat umbilical area	shallow depression	deep umbilical pit	total in lot
Baja California (Mexico)				
Punta Banda	6	5	1	12
La Mision	—	2	1	3
Rio Guadalupe	4	6	1	11
Punta Mesquite	7	5	—	12
Punta Piedra	12	3	1	16
Rosarito Beach	2	11	—	13
California				
San Diego County				
Point Loma	10	18	1	29
Flood Control Channel	2	9	3	14
La Jolla	23	19	1	43
Orange County				
Dana Point	3	—	—	3
Los Angeles County				
Point Fermin	—	2	—	2
White's Point	1	1	—	2
Ventura County				
San Nicolas Island	—	1	—	1
Rincon Beach	2	3	1	6
Santa Barbara County				
Santa Rosa Island	2	1	—	3
San Miguel Island	1	5	1	7
Gaviota	9	6	—	15
Government Point	2	8	—	10
San Luis Obispo County				
Morro Bay	1	—	—	1
Cayucos	6	4	—	10
Moonstone Beach	4	2	—	6
San Simeon	9	14	—	23
Monterey County				
Soberanes Point	—	6	—	6
Yankee Point	3	3	—	6
Point Lobos	4	4	—	8
Mission Point	4	2	—	6
Spanish Bay	6	—	—	6
Monterey Harbor	2	1	—	3
Santa Cruz County				
Santa Cruz	1	3	—	4
Scott Creek	2	2	—	4
San Mateo County				
Pigeon Point	1	5	—	6
Pillar Point	1	—	—	1
Frenchman's Reef	4	5	—	9
Moss Beach	—	4	—	4
Marin County				
Duxbury Reef	6	1	1	8
Drakes Estero	2	3	—	5
Tomales Point	2	—	—	2
Sonoma County				
Bodega	4	7	—	11
Carmet by the Sea	3	1	—	4
Shell Beach	—	3	—	3
Russian Gulch I	2	—	—	2
Salt Point	2	1	—	3
Horseshoe Point	9	2	—	11
Stewarts Point	1	6	—	7
Del Mar Point	10	6	—	16
Mendocino County				
Havens Neck	2	7	1	10
Arena Cove	7	17	2	26
Elk	2	7	2	11
Fort Bragg	2	3	—	5
Hardy	4	7	—	11
Humboldt County				
S. of Cape Mendocino	5	9	—	14
Del Norte County				
1 mi S. of Oregon Border	—	8	—	8
at Oregon Border	2	1	—	3
Subtotal:	199	249	17	465
Point Buchon	41	5	2	48
Cañada Tecelate	45	34	4	83
Total:	285	288	23	596

In the collection of the Department of Zoology of the University of California in Berkeley there is a number of small lots of *Tegula funebralis* from the shore of the Eastern Pacific extending from Lower California to the northern border of California. A total of 596 shells was examined for the presence or absence of an umbilical pit. This examination revealed that *T. funebralis* is indeed imperforate exactly as Adams stated, for not a single specimen in the 55 lots studied had an open umbilicus. However, it was also noted that a deep umbilical pit could be observed in many lots regardless of the place of origin (see Table 1); this was true for 13 of the 55 lots examined; a shallower pit was seen in 47 of the 55 lots, all of the previously mentioned 13 lots also containing such specimens. On the other hand, only 7 of these lots showed a complete absence of specimens with an entirely flat umbilical area.

It is my impression that had larger samples been taken in all localities the three types of umbilical areas (i. e. deep pit, shallow pit, and smooth area) would have been found to be more evenly distributed. Unfortunately, at the time these collections were made the problem of the umbilical area was not considered and usually only very small samples were retained as indicators of the presence of *Tegula funebralis* in a particular locality. Through the generous cooperation of Mr. Glen Bickford from the California Department of Fish and Game I have been able to examine two larger lots, one from the mainland shore in San Luis Obispo County and one from Santa Rosa Island. These two lots I considered large enough for taking some measurements (see Tables 2 and 3). Measurements of height in *T. funebralis* cannot be considered significant, generally speaking, because of the varying degrees of corrosion. More reliance may be put on the largest diameter of the shell.

Table 2

Population of *Tegula funebralis* from about ½ mile North of Point Buchon, San Luis Obispo County (Measurements in millimeters)

		flat	shallow	deep
largest	height	31.4	26.5	25.9
	width	31.7	25.7	27.4
smallest	height	4.5	12.9	21.5
	width	6.1	15.4	23.5

Table 3

Population of *Tegula funebralis* from West of Cañada Tecelate, Santa Rosa Island, Santa Barbara County (Measurements in millimeters)

		flat	shallow	deep
largest	height	35.5	36.1	41.2
	width	31.4	31.0	30.7
smallest	height	11.2	11.0	17.3
	width	11.8	13.4	20.8

Scanning Tables 2 and 3 one must gain the impression that a deep umbilical pit is limited to large (that is, older) shells. But studying the smaller lots in the collection this impression is dissipated. The smallest specimen in the collection, having a deep umbilical pit, is from Rio Guadalupe, Baja California, Mexico, and measures 17.0 mm in diameter. It is perhaps worth noting that the proportion of shells with a deep umbilical pit to the total population is fairly constant, i.e. 4%, while "flat" and "shallow" vary from approximately 85:10 (at Point Buchon) to 52:42 (at Cañada Tecelate). The percentage of shells with the deep pit seems to remain fairly constant in all populations, that is if we may make this deduction based on the two larger samples just discussed, either separately or together, or basing the assumption on the total figures of all samples studied.

Two other observations were made during this particular study. The first one is that the sculpture of the whorls is fairly constant throughout the range of distribution of the species; the "*aureotincta*" sculpture, as discussed in connection with *Tegula brunnea* (Philippi, 1848) (Stohler, 1958) and *T. rugosa* (Stohler, 1963) has not been seen in any specimen; not even the faintest indication of such a sculpture has been noticed, although I paid special attention to this feature of the shell.

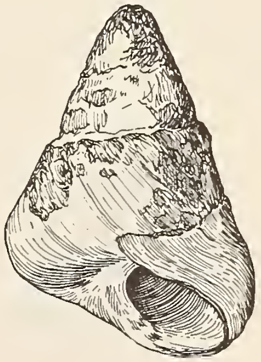

Figure 2: *Tegula funebralis* (A. Adams, 1855). Duxbury Point, Marin County, California. Oct. 30, 1947. Lateral aspect. *ex* Coll. Dept. Zool., Univ. Calif., Berkeley. (x 1)

The second observation is, however, of a more positive nature. At Duxbury Reef in Marin County a large proportion of the *Tegula funebralis* shells encountered are unusually high (Figures 2, 3); rough estimates made in the field vary slightly, depending on certain closely circumscribed areas scrutinized. In the sandy areas, devoid of all rocks, no *T. funebralis* are encountered, except very rarely a stray specimen ploughing through the sand on its way from one rocky area to another one. In areas with small rocks up to the size of a large fist, Tegulas abound and here the proportion of the high forms is estimated at about 40% of the total number; these rocky areas are bounded by large rocks forming actual reefs; Tegulas inhabiting this particular environment seem to comprise a larger percentage of high shells, probably as many as 75% or even more being of the type shown in Figure 2. The other members of these various *Tegula* populations conform to the more usual shape pattern (see Figures 4 and 5).

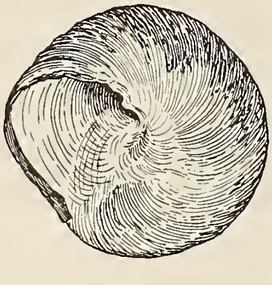

Figure 3: Same shell as shown in Figure 2.
Ventral aspect. *ex* Coll. Dept. Zool., Univ. Calif., Berkeley.
(x 1)

It seems plausible that these high forms represent an ecological variant, although I have not seen similar shells in any other collecting station along the coast of California and Lower California, even though in one or two places ecological conditions similar to those at Duxbury Reef seem to prevail. On the other hand, in general collections of *Tegula funebralis*, covering wide ranges of its distribution, such as are housed in the California Academy of Sciences in San Francisco, these large, high specimens can be readily picked out; when the museum label is examined it is found to read "Baulinas," "Bolinas" or "Duxbury," all three being, to some collector or other, the same spot.

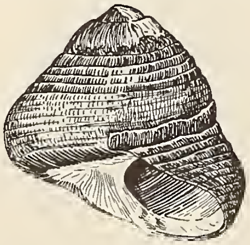

Figure 4: *Tegula funebralis* (A. Adams, 1855).
Mission Point, Carmel, Monterey County, California.
November 13, 1947.
Lateral aspect. *ex* Coll. Dept. Zool., Univ. Calif., Berkeley.
(x 1)

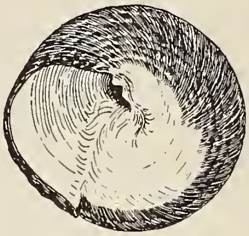

Figure 5: Same shell as shown in Figure 4.
Ventral aspect. *ex* Coll. Dept. Zool., Univ. Calif., Berkeley.
(x 1)

For the same reason as given in our previous papers, cited above, we do not consider the variety *subapertum* to be taxonomically valid; it is merely a variant, perhaps at the end of the range of variability for the particular character, but still one that is difficult to define exactly since what is a "depression" in the umbilical area must remain open to a very subjective appraisal by the observer.

On the other hand, a decision whether the Duxbury variant should be considered a taxonomically valid subspecies must be deferred, I think, until breeding experiments can be conducted to ascertain whether this is a heritable character, unaffected by environmental factors, or a character influenced only by some as yet unrecognized environmental condition.

ACKNOWLEDGMENTS

The illustrations reproduced here are the product of the fine artistic skill of Mrs. Emily Reid, Staff Artist in the Department of Zoology. I also wish to express my appreciation to Mr. Glen Bickford, not only for his generous donation of the shells discussed here, but also for many other sizable lots and numerous important data, which, it is hoped, will be used in a forthcoming study.

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